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The MONITOR

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The MONITOR is a quarterly publication of the Headquarters Air Force Materiel Command (AFMC) Pollution Prevention Integrated Product Team (P2IPT) dedicated to integrating environment, safety, and health related issues across the entire life cycle of Air Force Weapon Systems. AFMC does not endorse the products featured in this magazine. The views and opinions expressed in this publication are not necessarily those of AFMC. All inquiries or submissions to the MONITOR may be addressed to the Program Manager, Mr. Frank Brown.

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THE MONITOR ON INTERNET

This issue of the MONITOR is available on the Internet at the ASC site (http://www.ascenv.wpafb.af.mil/monitor.htm). The current issue of the MONITOR is in a Portable Document Format (PDF) file which requires a reader program for viewing or downloading. The Adobe Acrobat reader is available for downloading at no cost.

The Joint Group on Pollution Prevention (JG-PP): A Business Approach to Pollution Prevention

Today's competitive environment is driving both government and industry to bring "better, faster, cheaper, and cleaner" products to the market. Cost effective environmental solutions to systemic needs offers Business Managers a competitive advantage in their decision making process. Cutting edge industries and government organizations are integrating environmental considerations into their business processes.

Within the government, the Joint Group on Pollution Prevention Methodology (JG-PPMET) is a standardized process accepted by Program Managers to mitigate future costs and risks. JG-PPMET, a product of the Joint Group on Pollution Prevention (JG-PP), is a business and technical process, which brings together stakeholders to jointly implement cost effective environmental solutions to systemic needs. The JG-PP is a partnership between various government organizations and assists stakeholders in validating and implementing cost effective, less hazardous materials (HazMats), and associated processes at military and industrial facilities. To date, JG-PP has used the JG-PPMET on 20 projects across the Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA).

Background

In 1994, the Joint Logistics Commanders (JLC) chartered the JG-PP "to develop a process for jointly demonstrating, validating, and implementing environmental technologies to mitigate cost and risk." Initially, JG-PP projects targeted Original Equipment Manufacturer (OEM) sites, per DoD's Acquisition Pollution Prevention Initiative (AP2I).

In 1998, JG-PP was re-chartered to expand its focus to include sustainment. Additionally, NASA joined the group as a principal member. JG-PP's current charter, includes the following elements:

- Reduce/eliminate HazMats and associated process through joint service and NASA cooperation at contractor design, manufacturing, and re-manufacturing process locations.
- Avoid duplicating efforts in HazMat reduction across the DoD, NASA, and OEM sites by developing joint test and validation protocols to qualify alternative materials and processes.
- Leverage resources across the joint services and NASA stakeholders to reduce overall cost and risk, while meeting environmental requirements and facilitating block changes through Single Process Initiatives (SPIs).

Today, the JG-PP Working Group, is executing JG-PPMET. The JG-PP Working Group facilitates pollution prevention projects through partnerships with industry contractors; affected weapon system Program Managers and depot process owners; NASA center and enterprise managers; and the Defense Contract Management Command (DCMC). Currently, JG-PP is working 13 new depot related projects and six projects with NASA as a partner. The JLC's endorsement of the JG-PP and the leadership provided by the JG-PP Principals demonstrates DoD's and NASA's emphasis on integrating environmental decision making tools into their business processes.

Overview of the Six Phases of the JG-PPMET

The JG-PPMET, was initially developed in 1994 in response to JG-PP's original charter to implement pollution prevention projects at OEM sites. JG-PPMET has also proven to be a valid process for implementing projects in the sustainment community. JG-PPMET has integrated the participation of both business and technical stakeholder at key milestones to ensure the successful implementation of material/process changes across a wide spectrum of weapon and space systems and partners. In cases where the framework has come to completion, the return on investment has been significant. The six phases of the JG-PPMET are summarized below.

<u>Phase I – Identification</u>: Early buy-in of the stakeholder is a critical component of JG-PPMET. As a result, the Identification Phase is used to determine the interest in the specific program. This effort requires identifying all the potential DoD and OEM stakeholders, identifying the target chemicals/processes for reduction, and obtaining the contractor/Program Manager/depot agreement to participate. During the Identification Phase, an initial technology survey is conducted for a broad brush assessment of potential alternatives. In addition, an early Cost-Benefit Analysis (CBA) is conducted to assess the viability to the program being considered for inclusion into the JG-PP. This initial screening is used to allocate

resource between competing requirements so that the projects offering the greatest cost savings are first implemented.

Phase II – Technical: The products of this phase of the JG-PPMET include a Potential Alternative Report (PAR) and a Joint Test Protocol (JTP). The critical component of the Technical Phase is creating a JTP that is approved with stakeholder signatures. To obtain such a signed document requires identification of all the technical requirements and potential alternatives for the HazMat/process reduction under consideration.

During this phase, the CBA for the JTP test execution is established. The three CBAs developed during implementation of the JG-PPMET are used to support project selection, JTP execution, and SPI Block Change implementation. Additionally, the CBA is used to identify the total ownership cost. Factors used in this consideration include environmental reduction, quality of life and performance/technical risks.

Phase III – Business: In addition to ensuring the technical aspects of this project, the JG-PPMET requires that the business goals and requirements are understood and met before further work is conducted on the project. In this phase, the cost of testing proposed alternatives, sources of funding, available contract vehicles for testing, and an agreement to implement successful alternatives are identified. The key document produced in this phase is the Statement of Task (SOT). The CBA activities conducted under the Technical Phase help support this effort.

Phase IV – Alternative Demonstration/Validation: Generally, the Alternative Demonstration/Validation Phase is the longest portion of the JG-PPMET. This phase can vary from several months to several years of testing. During this phase, the required tests for the selected alternatives are conducted and the data analyzed. The results of the demonstration/validation are documented in the Joint Test Report (JTR), which is a product of this phase.

Phase V – Single Process Initiative: Once engineering authorities have validated an alternative(s), the industry contractor uses the SPI block change process to modify contracts for implementation across all affected weapon system and components. Depot sustainment maintenance and NASA activities use their respective service/agency change mechanism for implementation.

Phase VI – Implementation: During this phase, the selected alternative material/process is implemented into the depot, field, and OEM's manufacturing and sustainment maintenance operations.

Key Factors to the Success of JG-PPMET

The key factors to the successful implementation of the JG-PPMET include the following:

- commitment from top management;
- establishing an extensive network of government and industry partnerships;
- excellent communication networks; and
- developing standard products.

These factors are further discussed below.

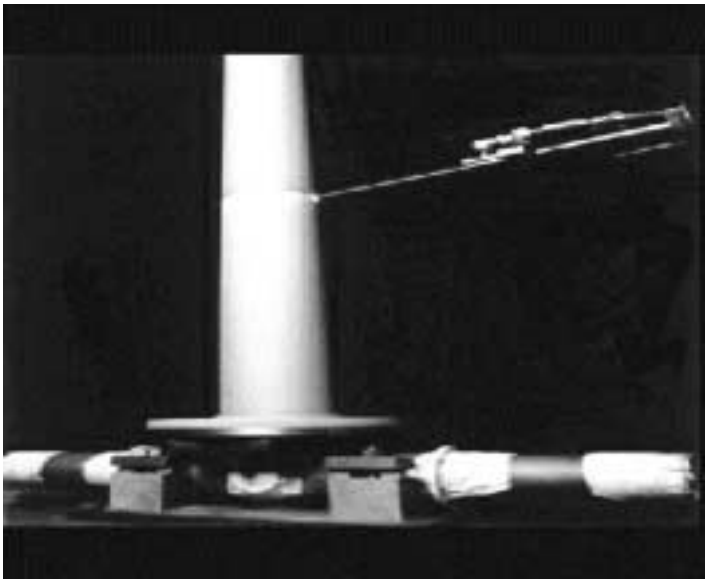
Commitment from Top Management – Top level buy-in to the JG-PP Program from the JLCs is the key factor to the success of the JG-PPMET. In May 1997, the Principle Deputy Under Secretary for Acquisition & Technology established AP2I. AP2I tasked a JG-PP Principal DCMC, with the lead for linking the SPI with the JLC endorsed pollution prevention projects. SPI is a DoD initiative, led by DCMC, which promotes acquisition streamlining through contractual block changes. Historically defense contractors have not obtained buy-in across service lines when seeking to change manufacturing processes.

The JG-PPMET leverages DCMC hosted Management Councils to ensure pollution prevention projects are structured to provide technically acceptable alternatives that can be implemented through an SPI block change. Depot sustainment maintenance activities use their respective service/agency change mechanism for implementation. The JG-PPMET is used to validate changes to contractor design, manufacturing, and depot sustainment maintenance process that are faster, cheaper, and use less HazMats and processes.

Partnerships – A second key factor to the success of the JG-PPMET has been leveraging financial and technical resources

through government and industry partnerships. On selected projects JG-PP has partnered with the National Center for Manufacturing Sciences (NCMS), the Hard Chrome Alternatives Team (HCAT), the Propulsion Environmental Working Group (PEWG), the Environmental Security Technology Certification Program (ESTCP), and the Canadian Department of National Defense.

One example of a successful partnership is with the HCAT. JG-PP has partnered with HCAT, a tri-service/industry group, to fully qualify High Velocity Oxygen-Fuel (HVOF) thermal spray coatings to replace hard chrome coatings for specific applications. Although the HCAT efforts to date have clearly demonstrated the technical viability of HVOF coatings, full qualification requires the involvement of all stakeholders with the military and defense. JG-PPMET offers the HCAT an established process to bring together the potential stakeholders that can include repair depot technical representatives and engineering authorities, weapon and space system program managers and single item managers, and structural engineers from the services and OEMs. HCAT/JG-PP projects are currently underway for landing gear components, hydraulic actuators, propeller hubs, and helicopter dynamic rotor components.



HVOF Technology

<u>*Communication Networks*</u> – A key lessons learned from the implementation of the JG-PPMET has been the importance of establishing appropriate communication and facilitation channels when dealing with a multiple weapon and space systems/service scenario. For each JG-PP project, one service is assigned as the lead for project implementation, although the project may impact multiple services. Additionally, one technical focal point is established for each project. This individual serves to coordinate communication and information flow between the various programs, engineers, and testing contractors. Communication flow through an established web site, strategic meeting throughout the JG-PPMET process, and video teleconferencing has helped establish an ongoing dialog between stakeholders. As a result, many stakeholders return to the JG-PPMET process and bring their requirements for potential solutions through this process.

<u>*Standardized Products*</u> – The standardization of the technical and business products derived for each project is another contributing factor to the success of the JG-PPMET. Technical information on possible alternative materials or processes is documented for each project in a PAR. CBAs are prepared to quantify the total cost of ownership for new alternatives versus currently used materials and processes. The JTP documents the technical stakeholders' engineering performance requirements to qualify alternatives. The SOT aggregates the results of the technical and business efforts in stakeholder's selection of test location and the contracted laboratory for test execution. The JTR documents the results of all testing, as approved by engineering authorities, and serves as the cornerstone for contract and maintenance process change. These products are available through the JG-PP web site (http://www.jgpp.com).

Conclusion

The success of the JG-PPMET is reflected in the bottom line. To date, JG-PP has expended $13 million on 20 projects. These initiatives, often involving multiple government and industry partners, will result in over $37 million in cost savings and cost avoidance and $78 million avoidance in duplication of effort since 1994. Specific return on investments on JG-PP projects are estimated between 0.1 – 3 years. For example, implementing a low VOC topcoat project at Raytheon, Dallas, which has completed all the phases of the JG-PPMET, has resulted in a cost avoidance of ten times greater than the DoD investment. Similar saving are anticipated for future projects as they complete the JG-PPMET. For more information about JG-PP or the projects, visit the JG-PP web site at http://www.jgpp.com. Points of contact include Robert Hill, NASA, at (321)-867-6958, Debora Meredith, Air Force, at (937) 257-7505, Winston de Monsabert, USN, at (703) 602-5336, George Terrell, USA, (703) 617-9488, Charlie Johnson, USMC, at (912) 439-6801 or David James, DCMC, at (703) 767-2124. ◆

Summary of Active JG-PP Projects

Project Name/Project #	JASPPA Lead	Key Personnel	Point of Contact
Alternatives to Electrodeposited Cadmium for Corrosion Protection and Threaded Part Lubricity Applications *J-95-MF-006*	Winston de Monsabert, 703-602-5334 Technical David Koehler, 703-617-5941 Technical-Alternate Robert Hill, 321-867-8759 Business David James, 703-428-0971 Business-Alternate	*Contractor:* Joseph Osborne, 425-237-8518 Judith Thomas, 610-591-3348 *DCMA:* Larry Hopper, 253-773-2938 Brad Bergan, 610-591-9161	David James, CTC, 814-269-6455 james@ctc.com
Chromium Electroplating Alternatives for Actuators *J-00-MF-020*	Debora Meredith, 937-257-7505 Technical and Business	*Technical Lead:* Bruce Sartwell, 202-767-0722	Gene Jeunelot, HQ AFMC/LGP-EV, 937-904-0152 gene.jeunelot@wpafb.af.mil
Chromium Electroplating Alternatives for Helicopter Dynamic Components *J-00-MF-021*	Winston de Monsabert, 703-602-5334 Technical and Business		Bruce Sartwell, NRL, 202-767-0722 sartwell@nrl.navy.mil
Chromium Electroplating Alternatives for Propeller Hubs *J-98-MF-012*	Debora Meredith, 937-257-7505 Technical and Business	*Technical Lead:* Bruce Sartwell, 202-767-0722 Robert Kestler, 252-464-9888	Warren Assink, HQ AFMC/LGP-EV, 937-904-0151 warren.assink@wpafb.af.mil
Lead-Free Electronics Soldering *J-01-EM-026*	Robert Hill, 321-867-8795 Technical and Business		Brian Greene, CTC, 814-269-2761 greene@ctc.com
Lead-Free Surface Finishes and Low-VOC Conformal Coatings *J-96-EM-008*	Robert Hill, 321-867-8795 Technical and Business	*Contractor:* Jeff Koon, 978-470-6223 *DCMA:* Louis Smith, 310-335-3729 American Competitiveness Inst: Joe Harris, 317-542-2048 Lucent Technologies: Donna Merriman, 201-724-8393 Raytheon Systems Co.: Ed Charles, 972-656-3678	Brian Greene, CTC, 814-269-2761 greene@ctc.com
Low/No-VOC and Non-chromate Coating System for Support Equipment *J-99-OC-014*	Debora Meredith, 937-257-7505 Technical and Business Tom Lorman, 937-257-7505	*SAIC:* Mike Surratt, 912-918-2902 Jim Dean, 912-918-2917	David James, CTC, 814-269-6455 james@ctc.com
Low-VOC Coatings for Medium Caliber Ammunition *J-98-OC-013*	David Koehler, 703-617-5941 Technical Robert Hill, 321-867-8795 Business	*Army:* Stanley Kaszupski, 973-724-7065 *Contractors:* Alliant Techsystems: Gary Wittmer, 612-931-5598 Galion, Inc.: Ron Buchanan, 419-468-5214 General Dynamics OTS: Dodwell Desilva, 562-904-7412	Julie Napotnik, CTC, 814-269-6255 napotnik@ctc.com
Low-VOC Identification Marking *J-95-OC-005*	Winston de Monsabert, 703-602-5334 Technical David James, 703-428-0971 Business	*Contractor:* Linda Lauer, 407-356-9236 *DCMA:* Ernie Eaton, 407-356-9479 Kenneth Ley, 407-356-9500	David James, CTC, 814-269-6455 james@ctc.com
Nonchromate Primers for Aircraft Exteriors *J-95-OC-002*	Debora Meredith, 937-257-7505 Technical David James, 703-428-0971 Business	*Contractor:* Richard Pinckert, 314-234-0623 Larry Triplett, 314-232-2882 *DCMA:* Ray Massey, 314-233-9199	Jerry Mongelli, HQ AFMC/LGP-EV, 937-656-2637 gerald.mongelli@wpafb.af.mil
Non-ODC Oxygen Line Cleaning *J-99-CL-015*	Debora Meredith, 937-257-7505 Technical and Business John Herrington, 937-257-8090	*Depot:* Jerry Gore, OC-ALC, 405-736-5080 Versar Inc.: Terry Caldwell, 405-739-0062 Bobby Walls, 405 -739-0062	Brian Greene, CTC, 814-269-2761 greene@ctc.com

FEATURED TECHNOLOGY

Dialysis Technologies Concentrate Processing Chemicals From Metal Finishing Processes

Dialysis technologies complement the membrane technologies, which are discussed in the companion article on pages 9-10. Diffusion dialysis (DD), electrodialysis (ED) and membrane electrolysis (ME) are not effective for treating very dilute waters or waters containing organic chemicals because these technologies separate ionic species from water. Therefore, these technologies are used to process concentrated solutions of ionic chemicals to reduce the costs for maintaining process baths and/or managing the wastewaters from various metal finishing processes.

Table 1 compares some of the aspects for DD, ED, and ME. These technologies differ from other membrane technologies discussed in the companion article because:

- they use ion selective membranes,
- ionic chemicals (instead of water) are transported across the membrane, and
- they do not use pressure to promote transport across the membrane.

Table 1. Comparison of the Aspects of Dialysis Technologies

Dialysis Technology	Species Passing Through Membrane	Driving Force for Separation	Name of Depleted Stream	Name of Concentrated Stream
Diffusion Dialysis	Anions and H3O+	Acid concentration gradient established across anion exchange membrane	Diffusate	Dialysate
Electrodialysis	Ionic chemicals	Electrochemical and two ion selective membranes	Dilution stream	Brine stream
Membrane Electrolysis	Positive (usually metal) ions	Electrochemical and one ion selective membranes	Anolyte	Catholyte

Diffusion Dialysis (DD) Technology

Diffusion dialysis anion exchange membrane separates metal contaminants from highly dissociated acids, as shown in Figure 1. DD is used to purify acids contaminated with metals from pickling, anodizing, stripping, etching, or passivation baths by separating mineral acids from metals (such as copper, chrome, nickel, iron, and aluminum) so that acid can be reused. Recovery rates in some instances are as high as 95 percent for acid solutions and 60 to 90 percent for metal contaminants (Cushnie 1994).

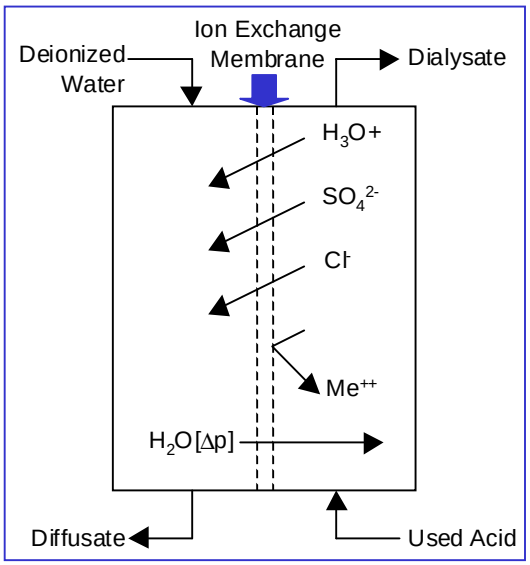


Figure 1. Streams in a Diffusion Dialysis Cell

DD separates acids from metal contaminants by establishing an acid concentration gradient across an anion-exchange selective membrane that separates two compartments. The anion-exchange selective membrane has a positive charge that permits the passage of anions (highly dissociated acids) but not cations (such as metal contaminants). Water is metered through the chamber on one side of the anion exchange membrane, causing the acid to migrate to that chamber and the metals to stay in the other. The diffusate containing purified acid is sent back to the process tank and the dialysate containing spent acid and metals is sent to the metal recovery or waste treatment system.

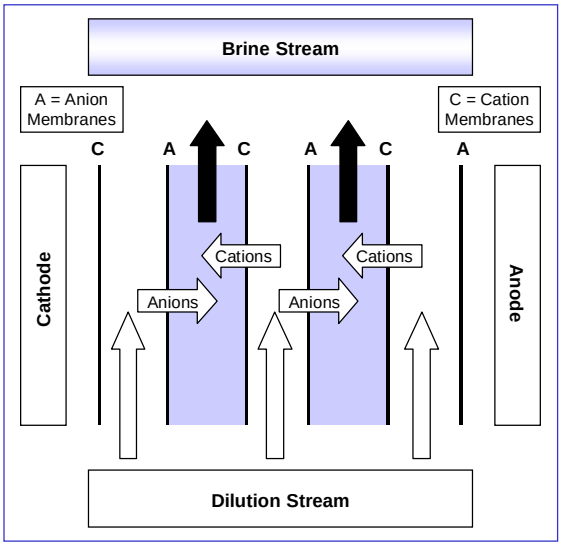


Figure 2. Membrane Permit Passage of Only One Type of Ion

Electrodialysis (ED) Technology

For ED, applying a DC voltage across a stack containing alternating cation and anion selective membranes induces separation of ions. Spacers that allow for flow of solutions separate the membranes. The entire stack of membranes and spacers is between a pair of non-corrosive electrodes. Figure 2 shows that these membranes permit the passage of only

one type of ion – cations through cation membranes and anions through anion membranes. The cations are attracted to the negatively charged cathode but an anion membrane interrupts their transport after they have passed through only one cation membrane. Similarly the transport of anions is interrupted after they have passed through only one anion membrane. Figure 2 shows how this creates a sequence of alternating chambers containing increased and depleted concentrations of salts. The flows from the chambers containing concentrates are collected as the "brine" stream and recirculated. The flows from the depleted chambers are collected as the "dilution" stream and recirculated. Feed is added to the dilution circuit and concentrated output is removed from the brine circuit.

DD and ED systems are becoming increasingly popular for chemical solution recovery especially because they are more efficient and less expensive than other recovery technologies for reclaiming acid. They also can remove metals and recycle water in plating or anodizing shops (EPA 1995). Platers commonly use electrodialysis to reclaim nickel and gold from plating rinsewaters.

Membrane Electrolysis Technology

Figure 3 shows that ME uses a cation membrane between two compartments containing DC electrodes. The two compartments are maintained with separate solutions – the catholyte or maintenance solution is in the cathode compartment and the anolyte or spent acid is in the anode compartment. The contaminant metal cations are transported from the spent acid to the maintenance solution because they are attracted to the cathode and can pass through the cation membrane. Anions in the maintenance solution are attracted to the anode in the spent acid solution but are not transported there because the cation membrane has the same charge as the anions.

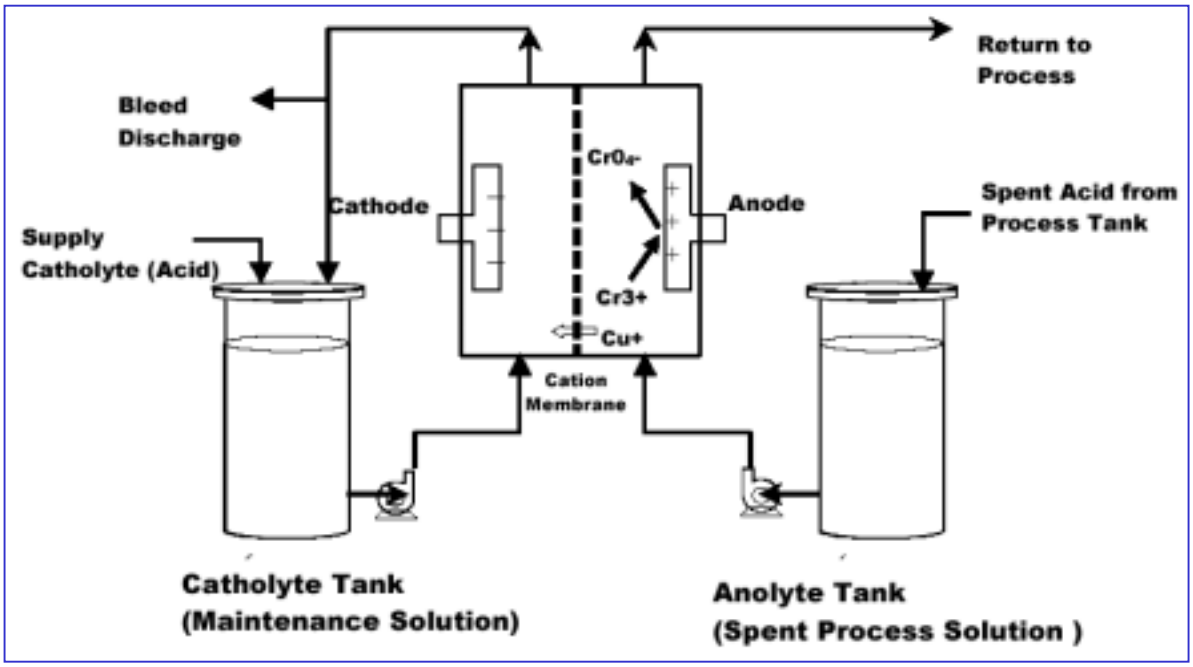


Figure 3. Typical Membrane Electrolysis System

ME has been used for rejuvenating ferric-based etching baths and Alodine (chromate conversion coating) baths by removing trace contaminant metals as well as restoring and maintaining the hexavalent chromium or ferric species. The oxidizing power for the process acid is restored by oxidation (trivalent chromium to hexavalent chromium or ferrous to ferric) at the anode.

Other sources of more detailed information include the Joint Service Pollution Prevention Technical Library website at http://enviro.nfesc.navy.mil/p2library, and the U.S. EPA's Technology Innovation Office website for Hazardous Waste Clean-Up Information at http://clu-in.org.

Source Reduction and Waste Minimization Opportunities for Metal Finishing Processes using New Membrane Technologies, Ken Martins, CH2MHill Engineered Systems, presented at NDIA 27th Environmental Symposium and Exhibition, 2001.

Metal Finishing Industry Manual, The Northeast Waste Management Officials' Association.◆

FEATURED TECHNOLOGY

Membrane Technologies Play an Important Role in Rejuvenating Metal Finishing Processes and Minimizing Wastewaters

Wastes and wastewaters from several metal finishing processes used by the military services are minimized using membrane technologies that function like the human kidney (which itself employs a membrane technology). These technologies separate dissolved and sometimes suspended species from the bulk of the water so that either the concentrate or the cleansed water can be returned to the process and the other purged. In applications where the concentrate contains dissolved or suspended contaminants, it is purged and the cleansed water is retained for make-up in the bath or used as rinsewater. In other situations, where the concentrate contains process chemicals, it is recovered. The excess water can be purged or recycled.

Continuous processing by membrane technologies: (1) extends the life of process baths by continuously purging contaminants, (2) maintains consistent process chemistry by recycling desirable components that were being lost, and (3) reduces discharges needed to purge oil or other contaminants.

Although the process template in Figure 4 can describe all of these membrane processes, the individual membrane technologies achieve the separations based on an interaction between the properties of the membranes and properties of the specific dissolved species. These interactions determine whether water or the dissolved species goes through the membrane. For many technologies, such as ultrafiltration (UF) or reverse osmosis (RO), the bulk of the water passes through the membrane along with a very small percentage of the dissolved species. For other technologies, such as electrodialysis (ED), diffusion dialysis (DD), or membrane dialysis (ME) the dissolved species pass through the membrane – not the water. (Please see companion article on pages 7-8.)

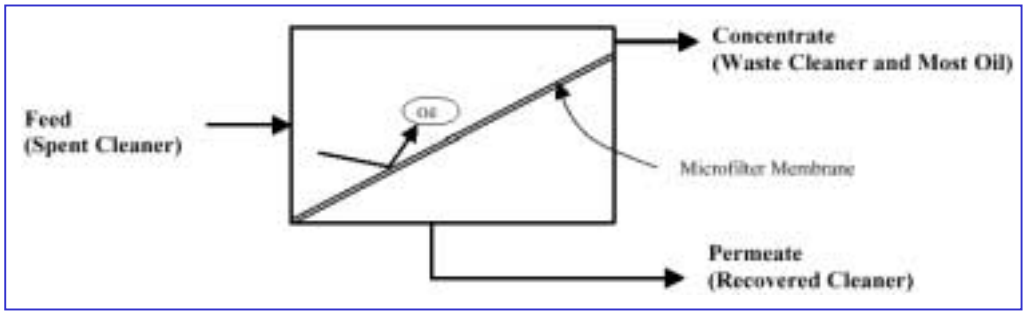


Figure 4. Schematic Ultrafilter Element

The characteristics of the membranes also determine the equipment configuration. Membrane systems are engineered using either bundles of hollow fibers or spiral-wound assemblies. The objective of each configuration is to minimize the size of the equipment needed to contain adequate surface area to maintain the flux needed.

Figure 5 shows a typical system applying membrane technologies. Engineering design features are included in these systems to avoid operating problems. Polishing filters are usually included so that the membranes can process liquid – not act as an expensive particulate filter. Often, the dirty liquid on the concentrated side of the membrane is recirculated from recycle tanks through the membrane module to maintain high fluid velocities that are independent of the flux through the membrane. The high fluid velocities are needed to forestall membrane plugging by

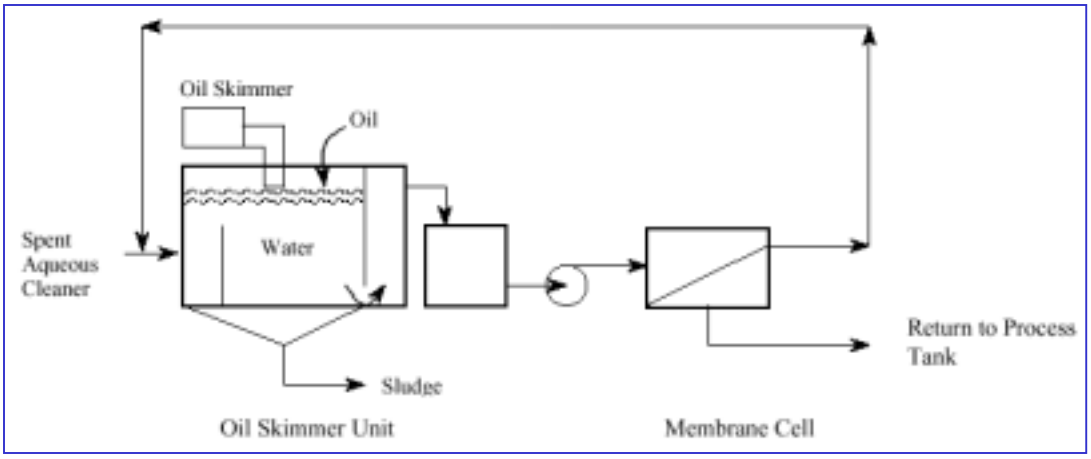


Figure 5. Typical Aqueous Cleaner Treatment System

scouring suspended solids from the membrane surfaces. The membrane separates and concentrates the remaining contaminants while water, and other components, such as solvent and cleaning bath constituents, pass through to a holding tank for the cleansed fluid. Various holding tank designs trap or skim floating oils and settle heavier solids.

The availability of membranes with different pore sizes provides the opportunity to tailor membrane selection to the application. UF membranes are suitable for particles in the molecular range of 0.1-0.01microns. Microfiltration membranes are similar to UF membranes but have larger pore sizes. RO semi-permeable membranes have smaller pore sizes and are applicable for particles in the ionic range of less than 0.001 microns.

RO systems produce the cleanest water being capable of removing up to 98 percent of dissolved solids, 99 percent of organics, and 99 percent of bacteria. (EPA 1995) However, RO systems need higher pressure than other membranes because of the smaller pore sizes. RO systems are also more susceptible to plugging because virtually all solids are removed. When macromolecules are present, UF and RO can be used in tandem, with UF removing most of the relatively large constituents of a process stream before RO application selectively removes water from the remaining mixture.

Microfiltration and UF are applied to remove oil and grease from aqueous and semi-aqueous degreasing baths to extend the life of the solution. Proper selection of the membrane allows the separation of nearly all of the surfactants and wetting agents from emulsified and soluble oils. The selection of the membrane depends on the molecular size of the molecular weight of the oil to be removed. Microfiltration and UF can also remove cleaning solution dragout from rinsewater lines. (Martins, K., 2001).

Reverse osmosis is usually reserved for lightly contaminated water such as rinsewater or waters that have been pretreated by other processes. When rinsewaters are processed, purified rinse water can be returned to the rinse system and the concentrate (which can be similar in composition to dragout) can be returned to the process tank.

More detailed information is available from several sources including the manual "Metal Finishing Industry" prepared by The Northeast Waste Management Officials' Association, the Joint Service Pollution Prevention Technical Library at website http://enviro.nfesc.navy.mil/p2library, and the U.S. EPA's Technology Innovation Office website for Hazardous Waste Clean-Up Information, http://clu-in.org.

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Environmental Report Card for the National Missile Defense Program the Programmatic Environmental, Safety, and Health Evaluation

DoD Regulation 5000.2-R, *Mandatory Procedures for Major Defense Acquisition Programs (MDAP) and Major Automated Information system (MAIS) Acquisition Programs*, required the Program Manager to initiate an Environmental, Safety, and Health (ESH) evaluation of the program and to maintain an updated evaluation throughout the program life cycle. This evaluation is known as the Programmatic Environmental Safety and Health Evaluation (PESHE).

The National Missile Defense (NMD) system is a fixed, land-based, non-nuclear missile defense system. The NMD system, currently under development, includes detection systems, command, control, and communications systems, and interceptor systems. The development and deployment of the NMD system is the responsibility of the NMD Joint Program Office (JPO) of the Ballistic Missile Defense Organization (BMDO).

The methodology and format for the NMD PESHE were approached with two primary goals in mind: 1) to develop a methodology and a document that would form a sound, defensible basis for the report card and 2) to make the report card understandable to a wide audience. Sources consulted to determine methodology and format were found to be general in nature, not well suited to the program, and limited in number and difficult to find.

The general outline selected by the NMD JPO for the NMD PESHE includes an Executive Summary, Environmental Safety and Health Management, National Environmental Policy Act (NEPA), Environmental Compliance, System Safety and Health, Pollution Prevention, Hazardous Materials Management, and Appendices.

The primary objective for the NMD PESHE is to identify and assess ESH risks to the NMD program. The first step is risk identification. Risks are identified in the PESHE utilizing the following methodology:

1. Key compliance Requirements
2. Current Status
3. Programmed Actions.
4. Program Risk.

The requirements that the program would be required to meet are summarized in a subsection, "Key Compliance Requirements". "Current Status" reviews the actions taken to date by the NMD Program describing the work that has already been done or is underway to comply with the requirements. "Programmed Actions" are those actions that are planned,

programmed, and funded but are not yet complete. "Program Risk" identifies program risk and summarizes the rationale for the risk rating or level.

The category and level of each risk must be assessed with respect to cost, schedule, and performance of the weapon system program. Each risk to program cost, schedule, and performance is evaluated based upon the likelihood and the consequence of the occurrence of an event and are categorized as low, medium, or high. This methodology provides a rational, objective, and well-accepted basis for risk assessment. ESH risk levels are easier for acquisition professionals to identify and can be more easily compared with other program risks.

The latest revision to DoD 5000.2R was due out in January 01. New requirements will include a new subsection for Explosive Safety and an explicit requirement for evaluation of program environmental risks. Another enhancement to be incorporated in future versions of the NMD PESHE will include the development and use of a written protocol for evaluation of each of the six ESH areas evaluated to aid in formalizing the risk identification and evaluation process.

The NMD PESHE has evolved into an effective, objective, management tool for the NMD Program and has been praised as a model document for a weapon system acquisition program.

For more information contact: Mr. Eric Sorrells (Eric.Sorrells@md.redstone.army.mil); Mr. Chuck Kennedy (Chuck_kennedy@earthtech.com) or Mr. Dan Spiegelberg (dspiege2@csc.com). ◆

Moving Into Compliance Management

Patuxent River Naval Air Station (NAS), like many other Department of Defense (DoD) facilities, is subject to a host of environmental regulatory requirements. An analysis of its existing commitments indicates that NAS is subject to 4,000 applicable compliance regulations. Keeping track of these compliance requirements has proved challenging to NAS. In the past, compliance with environmental requirements has been consequence-driven to avoid penalties imposed for violations. However, Patuxent River NAS is in the process of developing *Compliance*, a software tool designed to identify and track environmental compliance requirements and their associated tasks for NAS operation and facility projects. The development of the tool is in response to a decision by the Air Station's environmental program to assume a more pro-active and preventive posture towards environmental compliance rather than reactionary. The ultimate goal is to put into place, a system that will integrate environmental requirements for compliance into the everyday workflow process. An integral step in this project is environmental planning.

The *Compliance* software attempts to implement a more pro-active approach in dealing with environmental tasks by ensuring that all of the facility's environmental compliance requirements and related tasks are captured in the *Compliance* system. NAS has classified its environmental requirements into the categories listed in Figure 6. Identifying tasks under these headings allows NAS to maintain an overview of its current compliance with Federal, DoD, State and Environmental Protection Agency environmental regulatory requirements. *Compliance* will allow NAS to track all compliance requirements simultaneously. In addition, the tool will allow NAS to plan and prioritize effective measures for maintaining compliance rather than continuously reacting to violations triggered by being out of compliance.

- Inspections
  - Internal Audits
  - External Audits
- Plans
  - Instructions
  - Reports
- Permits
- Regulations
  - Executive Orders
- Memoranda
  - Memoranda of Understanding
  - Memoranda of Agreement

Figure 6. Categories of Environmental Requirements

The Environmental and Natural Resource Management System (ENRMS) is the existing stand alone software application used to track compliance. However, ENRMS is limited in that it only allows users to track some environmental tasks. In addition, the ENRMS only tracks work related to inspections. The *Compliance* software builds upon ENRMS and broadens the application to encompass all categories listed in the text box above.

The information tracked by *Compliance* includes general information such as Name/Title, Installation ID, and Issuers ID Number. The tool also includes date related information such as Year Requirement Initiated, Start Date, End Date and

Task Required Completion Date. Additional information is available to establish relationships between specific tasks and work items needed to maintain compliance.

The ultimate goal will be to integrate compliance requirements with the business processes in order to link actual work execution to the environmental requirement. Eventually, *Compliance* will be able to track actions generated from the planning and compliance monitoring stage. Out of the 4,000 applicable compliance regulations, NAS must monitor and automate the compliance requirements presented in Figure 7.

- 4300 sampling and analysis events per year
- 1715 reports per year
- 23 local plans and instructions
- 6700 inspections per year
- 110 compliance issues identified per year
- 81 permits requiring attention per year

Figure 7. Patuxent River NAS Existing Compliance Requirements

Establishing a relationship between the task and work item becomes very important in *Compliance* because: (1) funding for some tasks can only occur once a work item is created and assigned to a designated task, and (2) assigning the work item to a task establishes a work flow process for the overall compliance requirement and ensures the task will be completed.

Compliance is already being used by environmental program managers who are testing the software and familiarizing themselves with its applications. Testing the software is a necessary step before moving forward with the next stage of software development.

Next Steps

The next step in the development of the software is to link the environmental requirements to assets and or processes. It is also essential to establish a link between an individual and a task to ensure accountability for accomplishing tasks needed to meet compliance requirements. In monitoring these activities, the goal will be to change the process and or eliminate the originating compliance requirement. In the event that the process requirement cannot be eliminated, NAS will look for opportunities to integrate automated triggers in the process to ensure compliance is being accomplished.

For additional information, please contact Larry Donmoyer Patuxent River Naval Air Station (301) 757-4766. ◆

The Environmental Planning Checklist

The Environmental Planning Checklist (Checklist), is a software application developed by Patuxent River Naval Air Station (NAS Pax and designed to promote a proactive posture to ensure compliance with environmental regulations. The Checklist software enables project planners to review projects for environmental constraints while ensuring the integration of work item and environmental background. Developed by facility planners, environmental managers and software developers, Checklist encourages “thoughtful front-end planning” as opposed to “last minute compliance” that had become the traditional and accepted approach at NAS.

Checklist was created to provide an automated method for planners to consider the environmental consequences/liabilities related to projects. Organized in an interview format, Checklist is comprised of 93 regulation-driven questions categorized into twenty-two media heading sections. The software allows environmental planners to answer questions about their specific project. The interview process is an essential component of the Checklist software. It can be completed in one hour and can be tailored for individual projects.

Answering yes, no, or don’t know to any of the 93 regulatory questions will prompt the software to present answers in the database that identify the environmental constraints associated with the answers, as well as any required actions. In addition, messages that appear on the screen based on the answers to the question warn project planners what steps need to be taken to maintain compliance with environmental regulations. For example, the software can inform the user whether a permit must be obtained or if a plan must be written. The system also offers helpful information that should be considered before moving forward with a project. Utilizing Checklist early in the planning process helps to mitigate or avoid work stoppage situations and delays that occur with last minute attempts to comply with environmental requirements.

Once the Checklist interview is completed, the user has the option of generating four types of reports. These reports

include: 1) project profile report (project description and customer information), 2) outstanding issues (list of questions answered "don't know"), 3) action items (lists of permits, plans, or reports required to ensure compliance; and 4) environmental checklist report (lists of questions answered for a project, action items, and the individual who answered the questions. Other features available in the Checklist software include a link with Report Generator Object (RGO) that allows the application to generate reports and electronic document manager (EDM). Checklist is compatible with Work Item Management (WIM), an item tracking system. It also has a Geographic Information System (GIS) application that allows project planners to view a map of NAS Pax and visually see if their project is near a critical area. It is also compatible with a new tool, Compliance Management. Compliance tracks all types of environmental tasks to help planners know if they are compliant.

Future versions of the Checklist (Version 4.0) will include a Reassessment feature that will require planners, under specific conditions, to reevaluation their Checklist answers. Another feature, "Versioning", will allow for a real time updating of Checklist answers and will allow the user to update Checklist questions in response to changing environmental regulations and requirements. Users will also be prompted to update their answers to the interview questions. While using the current version of Checklist, NAS Pax has observed several benefits listed in Figure 8. These benefits reassure NAS Pax of the value and importance of front-end planning as a worthwhile investment.

- Prevent halted projects
- Decrease in project planning time
- Increase in environmental awareness among Public Works personnel
- Prevent loss or degradation to historical, archaeological and other environmental sites

Figure 8. Benefits of Using Checklist

For additional information, please contact Ms. Lasandra Teeters, NAS Pax, Environmental Division, (301) 757-4872.

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Comprehensive Execution of the Compliance Through Pollution Prevention Program at USAFE Installations

The United States Air Force (USAF) goal is to reduce environmental compliance risks and associated costs through the Compliance Through Pollution Prevention (CTP2) process. Implementation of the CTP2 program is required by Air Force Instruction (AFI) 32-7080. The United States Air Force in Europe (USAFE), is responsible for complying with environmental regulations and requirements similar to USAF facilities within the United States. However, USAFE has modified the CTP2 process to tailor it to overseas environment, local, national and Final Governing Standards requirements. Using the CTP2 process, USAFE implemented a two-year project to inventory, evaluate, rank, and assess all compliance site activities in Europe.

The USAFE CTP2 process consists of three Phases. The first phase, Phase I, involved the identification of compliance sites. Phase II involved prioritizing the compliance sites based on cost and risk. Under Phase III, those compliance sites rated as a top priority were evaluated for cost effective P2 projects. Phase I of the USAFE project identified a total of 6,826 compliance sites. Under Phase II, USAFE staff used a four-step process to identify the compliance burden.

The compliance site inventory was prioritized and reviewed (by media type) to identify which compliance sites contribute most heavily to the installation's compliance burden. The priority compliance sites are presented in Figure 9. Ninety-five percent of the compliance sites in Figure 9 are located at four USAFE bases. These bases include Aviano AB, Ramstein AB, RAF Fairford and RAF Mildenhall.

Media	Number of Sites
Air	1
Hazardous Material	130
Hazardous Waste	60
Wastewater & Stormwater	13

Figure 9. USAFE Priority Compliance Sites by Media

Under Phase III, P2 projects were identified to address the compliance sites with the greatest burden, focusing on projects and process changes that would eliminate the site as a compliance site or reduce the compliance burden. The analysis of the USAFE inventory indicated that approximately two-thirds of the hazardous waste generated in 2000 consisted of waste oil, oil contaminated solids, lead acid batteries, and paint waste. Thirty six percent of the total hazardous waste is waste oil. The generators of the hazardous waste throughout USAFE are associated vehicle maintenance, ground equipment and aircraft maintenance. Using the CTP2 process, USAFE personnel

identified several P2 projects to address the generation of hazardous waste. These projects, along with information on the number of bases affected, project costs, savings, payback year, and reduction of waste is included in Figure 10. USAFE environmental personnel believe CTP2 is a valuable process and tool that can encourage the transfer of P2 technology between various locations and that can help ensure compliance with environmental requirements.

Hazardous Waste	P2 Project	Bases	Project Cost ($)	Savings ($/yr)	Payback (yr)	Reduction ($/yr)
Waste Oil	Oil Analysis Program	2	$80,000	$92,000	0.9	$14,000
	Bypass Oil Filters	2	$14,500	$3,400	4.3	$1,000
Oil Contaminated Solid Waste	Pneumatic Spill Vacuums	6	$74,000	$86,000	0.9	$27,300
	Vacuum Oil Change Systems	6	$29,000	$27,600	1.1	$39,000
	POL Dispensing Units	6	$19,000	$41,500	0.5	$11,300
	Absorbent Pad Wringers	4	$25,200	$15,100	1.7	$19,000
Lead Acid Batteries	Solargizers	2	$9,000	$10,000	0.9	$1,100
	Gell Cell Batteries	2	$0	$33,000	Immediate	$9,500
Paint Waste	Filtered Paint Gun Cleaner	2	$9,300	$3,600	2.6	$700
	Local Test to Extend Shelf-life	3	$8,400	$29,000	0.3	$3,700
	Decal Machines	1	$4,800	$3,700	1.3	$150

Figure 10. USAFE P2 Projects

For additional information, please contact Stephan Escude, USAFE Pollution Prevention Program Manager, Ramstein AB Germany or at stephen.escude@ramstein.af.mil. ◆

Camp Lejeune Sustainable Development - A Plan for the Installation's Future

Marine Corps Base (MCB) Camp Lejeune is located in southeastern North Carolina. Five major Marine and two Navy Commands are stationed at Camp Lejeune, including the 2d Marine Division, the 2d Force Service Support Group (2d FSSG) and Command Element, and the II Marine Expeditionary Force (II MEF). Encompassing over 153,000 acres, 11 miles of beach and situated in the state of North Carolina, MCB supports 144,000 Marines, Sailors and their families. The infrastructure includes 6,800 buildings and facilities, 450 miles of roads, 37 miles of railroad, an advanced wastewater treatment plant, five water treatment plants, and a lined municipal solid waste landfill.

MCB Camp Lejeune has made significant and commendable strides and progress regarding pollution prevention, natural resource management, air quality, and hazardous waste reduction. However, because of its growing population and existing responsibilities, MCB Camp Lejeune sees sustainable development as a logical next step needed to manage the future growth and resources of the Base as it moves into the new millennium.

To this end, Camp Lejeune has developed a Sustainable Development Plan, the first of its kind within the Department of Defense. The plan defines sustainability at the Base and develops indices to measure progress at meeting sustainability goals. Also included in the plan is a framework for sustainability, a sustainability vision for 2025, an implementation strategy, as well as the identification of barriers to implementation. The plan also identifies existing and future projects that should be implemented to ensure Camp Lejeune meets its sustainability goal.

Under the leadership of the Environmental Management Division (EMD), Camp Lejeune's major commands are moving toward the goal of sustainability by: 1) guidance development 2) training, and 3) base order development. The sustainable development plan consists of three components 1) The Environmental Sustainability Guidance Manual (ESGM), 2) *The Natural Step* Training and, 3) Sustainability Base Order.

The ESGM is an essential component of the Sustainability Development Plan. It provides the support infrastructure and will help commanders plan, develop and implement sustainable operations for the next 25-50 years. The ESGM is organized into eight operational categories that will assist in the development of measures, the implementation of the strategy and project development. These operational categories are listed in Figure 11. The key goals of the ESGM are to: 1) eliminate or minimize the source of pollution 2) shift energy demand to a renewable alternative or a less polluting alternative, and 3) maximize the efficiency of the system. Included in the ESGM are environmental regulatory drivers, including Executive Orders, (EO) that support Camp Lejeune' efforts to move forward with the goal of sustainability (see Figure 12). In addition, the ESGM provides the organizational framework for developing a sustainability team that will implement sustainability. The team will consist of a Sustainability Program Manager, Sustainability Review Board, and eight Sustainability Category Stewards.

- Water Resource Management
- Transportation Systems
- Energy Management
- Building Systems
- Natural Resources Management
- Procurement
- Solid and Hazardous Waste Management
- Air Quality

Figure 11. ESGM Operational Categories

- EO 13101 - Greening the Government through Waste Prevention, Recycling and Federal Acquisition
- EO 13123 - Greening the Government through Efficient Energy Management
- EO 13134 - Developing and Promoting Biobased Products and Bioenergy
- EO 13148 - Greening the Government through Leadership in Environmental Management
- NAVFAC Statements 98-02 and 98-03 on the design of sustainable facilities and infrastructure

Figure 12. Drivers that Support Sustainability

The Natural Step component provided a forum for EMD personnel to improve their understanding of sustainability and to discuss its meaning and implications for Camp Lejeune. During a three-day training session, EMD staff created a high level systems map of Base operations to identify the greatest issues related to sustainability, and discussed opportunities to integrate existing environmental initiatives under a "sustainability umbrella".

The 1999 *Sustainable Planning - A MultiService Assessment*, developed by Naval Facilities Engineering Command, suggests that the adoption of a Base Order is the most definitive method for achieving sustainability because it is the primary method of executing the Base's mission. A draft Base Order has been developed by Camp Lejeune that provides a brief description of the ESGM, outlines the implementation strategy for sustainability, and defines the roles of each sustainability team member. In addition, it provides a clear directive from the Base Commander that "within economic means, the base will implement sustainability as a means to enhance its overall mission". With the Base Order in hand, Camp Lejeune is poised and ready to continue its efforts to ensure the Base meets its sustainability goals.

For additional information, please contact Ms. Emily Sylvester (910) 451-9455, Mr. Doug Piner (910) 451-5063 or Mr. H. Allen Davis (770) 604-9095 at MCB, Camp Lejeune.◆

Executive Order 13148 Interagency Workgroup Request for Federal Agency, Field-Level Comment: Executive Order 13148, Section 503

Executive Order (EO) 13148, section 503, requires that a Federal interagency Workgroup develop a list of chemicals used by the Federal Government that may result in significant harm to human health or the environment and that have known, readily available, less harmful substitutes for identified applications and purposes. EO 13148 further requires that Federal agencies (with certain exceptions) reduce their use of those chemicals for the identified applications by fifty percent by December 31, 2006. The requirement applies only to Federal agencies. The reduction requirement applies to each Federal agency; facility-specific efforts are at the discretion of each agency.
EO 13148 states that development of the list shall consider:

1. environmental factors including toxicity, persistence, and bio-accumulation;
2. availability of known, less environmentally harmful substitute *chemicals* that can be used in place of the priority chemical for identified applications and purposes;
3. availability of known, less environmentally harmful *processes* that can be used in place of the priority chemical for identified applications and purposes;

4. relative costs of alternative chemicals or processes; and
5. potential risk and environmental and human exposure based upon applications and uses of the chemicals by Federal agencies and facilities.

The technology transfer goal of section 503 of EO 13148 is to leverage pollution prevention leadership already achieved at Federal facilities by ensuring that information on successful efforts is made available across the Federal community. To support this objective, where an agency can demonstrate that it has previously reduced by fifty percent the use of a chemical identified by the workgroup, then the agency may elect to waive the fifty percent reduction goal for that chemical required by EO 13148.

The EO 13148 interagency Workgroup has prepared a draft list of chemicals, applications and associated alternatives that reflect the criteria described above. The draft list was generated from experiences provided by field-level Federal facility personnel and is presented below. The list is preliminary and chemicals, specified applications and proposed alternatives on the draft list are not necessarily those that will appear on the final section 503 list and may change based upon comment. This notice is also available on the World Wide Web at: https://www.denix.osd.mil/denix/DOD/Working/EO13148/eo13148.html, and www.epa.gov/fedsite.

Request for Comment

The Workgroup is requesting that appropriate Federal facility field-level personnel review and comment on the draft list of chemicals, applications and alternatives. The Workgroup will prepare documents and guidance to assist Federal agencies and facilities in meeting the objectives of section 503. Where proposed alternatives are associated with equipment replacement, the guidance will likely target cost effective reduction of environmental risk by phasing out use for specified applications as the equipment using the target chemical reaches its expected service life. Additional technical assistance on effective alternatives will be provided in the guidance.

US Department of Agriculture offices and agencies are to submit their comments to their respective agency environmental pollution control coordinators who will then forward all comments to the Hazardous Materials Management Group (HMMG). HMMG will consolidate USDA comments and send them to the interagency Workgroup through the US Environmental Protection Agency.

Comments will be considered in preparation of the final list which will be announced through the interagency Workgroup and made available on the websites listed above. In addition, fact sheets and other guidance documents and tools will be prepared by the EO 13148 Workgroup to assist facilities in implementation of the section 503 requirements. Implementation of the reduction requirements of this section of EO 13148 will begin in calendar year 2002.

Federal facility personnel are requested to review and comment on the draft list of chemicals, alternatives and uses considering the factors described in section 503. Federal facility personnel are also requested to provide discussion of any guidance or technical information considered necessary to implement reduction requirements of EO 13148. The EO 13148 Workgroup is particularly interested in facility level comment on the following issues:

- environmental or human health issues, including exposure, associated with use of the proposed chemical for the specified application at Federal facilities;
- experience, including success or failure, of the proposed alternatives at Federal facilities (for the specified chemical and application);
- potential logistical problems, such as necessary changes to military specifications, that affect implementation of the alternatives at Federal facilities;
- reasonable thresholds for proposed chemicals below which the Executive Order reduction requirement would not apply at Federal facilities;
- situations where disposal/removal of proposed chemicals may pose a threat to the environment or human health;
- chemicals, applications and alternatives used by Federal facilities which meet the criteria in EO 13148 but are not listed on the proposed list;
- chemicals with specified applications at Federal facilities which pose environmental or health problems and for which currently there exist no less harmful, cost effective alternative;

- criteria and methods to determine progress towards reduction goals established by EO 13148;
- information (to be included in fact sheets) necessary to implement the reduction requirements of section 503.

Federal facility personnel are requested to comment through electronic mail to EO13148@epa.gov on any of these aspects as appropriate and are encouraged to provide any additional comment they believe may be relevant to the section 503 list and implementation of the reduction requirements. ◆

Use	Chemical	Proposed/Draft Alternatives
Temperature and pressure measuring devices (medical and industrial)	Mercury	Aneroid manometers - digital and electronic temperature measuring devices
Switches	Mercury	Electronic thermostats - mechanical switches, ultrasonic and photoelectric sensors
Lab Use	Mercury	Zinc formalin, sample freeze drying
Surface coating/plating processes	Cadmium	Alternative metal coatings, metal deposition, flame coating, limited area plating
Surface coating/plating processes	Chrome (chromium VI)	Alternative metal coatings, metal deposition, flame coating, limited area plating
Surface coating/plating processes	Nickel	Alternative metal coatings, metal deposition, flame coating, limited area plating
Wastewater Disinfection	Chlorine (solid and gaseous)	Ozone treatment, UV light, chlorine dioxide
Biocide in cooling towers	Chlorine (solid and gaseous)	Ozone treatment
Photographic Operations	Silver	Digital photographic processes
Radiography (medical and industrial)	Silver	Digital computer radiography
Tin/Lead Soldering	Lead	Tin copper eutectic, Tin sliver eutectic
Herbicide	2,4-Dichlorophenoxyacetic Acid	Process changes and native landscaping
Fungicide (acquaculture)	Formalin	Hydrogen peroxide
Drycleaning	Perchloroethylene	Process change: “wet” cleaning systems, liquid carbon dioxide
Medical/general Sterilizer	Ethylene Oxide	Gamma, electron beam radiation, vapor phase hydrogen peroxide, peractic acid
Pesticide/insecticide	Methoxychlor	Integrated Pest Management including process changes
Pesticide	Napthalene	Integrated Pest Management including process changes
Pesticide/herbicide	Pendimethalin	Integrated Pest Management including process changes
Pesticide	Pentachlorobenzene	Integrated Pest Management including process changes
Pesticide	Pentachlorophenol	Integrated Pest Management including process changes
Wood Preservative	Pentachlorophenol	Removed plastic lumbers and timbers, steel, aluminum
Insulating material (dielectric fluids in transformers and ballasts)	PCBs	Early retirement of existing PCB containing equipment

EO 13148 Section 503 Chemical List

Pollution Prevention in Aerospace and DoD Painting Operations: Case Studies in Successful Elimination of MEK and Lacquer Thinner

The use of Methyl Ethyl Ketone (MEK) and lacquer thinner in clean up and surface preparation activities in painting operations at aerospace and Department of Defense (DoD) facilities has contributed significantly to the release of air emissions, hazardous air pollutants (HAPs), volatile organic compounds (VOCs) and the generation of waste disposal costs. Over 50% of the wastes generated by a painting facility are attributable to the use of MEK and lacquer thinner. Eliminating MEK and lacquer thinner will help facilities meet Aerospace NESHAPS and Executive Order 12856 and will help reduce hazardous waste generation. Two DoD installations, U.S. Army Aberdeen Proving Ground, and Eglin Air Force Base (AFB) have successfully identified alternatives to using MEK and lacquer thinner resulting in cost savings associated with the purchase of hazardous materials, waste disposal costs and other benefits such as reduced worker exposure to hazardous materials. The details of how these two installations eliminated the use of MEK and lacquer thinner in their paint cleaning activities is presented below.

The Auto Body Shop at Aberdeen Proving Ground used lacquer thinner to clean paint guns after their use. Auto body personnel used 70 gallons or more of lacquer thinner a month. The frequent disposal of used lacquer thinner and the purchase of new thinner was a major source of emissions and hazardous waste. In finding an alternative, the research team's goal was to identify a cleaning alternative that contains no hazardous air pollutants, is non-flammable, and presents minimal work exposure risks. In response to these criteria, Inland Technology Incorporated developed and patented EP-921™, a low toxicity solvent cleaner that contains less that 1% VOCs, no ozone depleting chemicals or EPA 17 chemicals, and a has a flashpoint of 156° F. The alternative was developed to mimic the Hansen's Solubility Parameters of MEK. The new cleaner is effective in removing all uncured and semi-cured paints used by the Army, including chemical resistant CARC coating. In addition, a new filter system was engineered for the cleaning process to maximize cost effectiveness. The Edge Tek™ Filtration System filters the EP-921™ solvent to 0.1 micron and removes a significant amount of the solids, thereby allowing reuse of the EP-921™.

The new cleaner and filter system was tested in May 1996 at two paint gun cleaning stations for a period of 47 months. After testing, researchers found that the volume of hazardous waste disposed was reduced by more than 85%. In addition, the only wastes being disposed of are the filter elements and small amounts of settled paint solids. The results of the MEK study at Aberdeen Proving Ground are presented in Figure 13.

- Reduced hazardous waste disposal by >85%
- Reduced emissions of HAPs, VOCs and EPA 17 chemicals to zero
- For a period of 47 months, reduced total costs from $14,805 to $5,142 (a cost savings of nearly 300%)
- Reduced airborne emissions from 11,515 pounds of HAPs to zero

Figure 13. Aberdeen Proving Ground Case Study Results

At Eglin Air Force Base, an alternative clean-up solvent was needed to remove uncured epoxy primers and polyurethane topcoat paints. Staff use cleaning tanks to clean paint guns after their use. However, the tanks are inefficient in cleaning the small openings and valves in the paint guns, requiring additional staff time to disassemble the guns and hand detail all of the parts with an MEK and brush. Base personnel use about 5,200 gallons of MEK a year to clean paint guns. The blend of waste paint and MEK result in 27,400 pounds of hazardous waste per year. In addition, the shop generates over 14,000 pounds of hazardous air pollutants and VOC air emissions each year.

In attempting to identify an alternative solvent, the Eglin AFB Inland Technology Task Force worked to find a solvent that would clean high solids paints but would not destroy the seals inside the gun head. EP-921™, developed by Inland Technology and used successfully at Aberdeen Proving Ground was selected as the alternative to remove uncured and semi-cured paints. In addition, equipment was needed that would allow for the flushing of the gun head assemblies, cleaning of the cup interiors, and cleaning of the cup and gun exteriors. This equipment needed an air-operated pump and would utilize the Edge Tek™ Filter System to minimize the disposal of the used EP-921™. In response to this request, the IT-45SSER™ was developed. It is 37"X31"X 74 high, constructed of 14-gauge schedule 304 stainless steel, utilizes an air-operated diaphragm pump and is equipped with the Edge Tek™ Filter System including a 25-micron resin prefilter. After a testing period of 14 months, the new gun washer demonstrated promising results including the reduction of 27,000 of hazardous waste. Other results are presented in Figure 14. The IT-45SSER™ Gun Washer and EP-921™ have been assigned a National Stock Number and are currently in used by the DoD.

For additional information, please contact Mr. Joseph Lucas, Inland Technology Incorporated at (253) 383-1177. ◆

- Enabled shop personnel to clean guns and cups in an open tank without breathing MEK fumes
- Eliminated the need to wipe the exterior or interior gun head and cup dry
- Eliminated the degradation of gun seals and clogging of spray ports in gun heads
- Eliminated use of MEK
- Reduced HAPs and VOCs from cleaning process
- Generates only 30 gallons (240 pounds) of hazardous waste
- Reduced hazardous waste of more than 27,000 pounds

Figure 14. Eglin Air Force Base Case Study Results

Flameless Steam 5X Technology for Munitions Scrap Metal

The DoD has numerous target, bombing, and firing ranges that have accumulated a substantial amount of high-value recyclable scrap metal, in the form of range residue. This material is collected in range sweeps and removal operations at active ranges, and UXO removal operations at closed, Transferred, and Transferring (CTT) sites. These items often have explosives residue after detonation. The DoD requires that range managers ensure that range residue does not contain ammunitions, explosives or other dangerous articles (AEDA) prior to release to the public for recycling. One of the DoD's standard accepted methods to insure that these items are free from AEDA is to provide 5X treatment, in accordance with the Department of the Army Pamphlet 385-61. 5X treatment consists of holding a contaminated article at a temperature of 1000 °F for a 15-minute time period to ensure that the contamination has been destroyed. However, in several states thermal treatment resembling incineration does not receive public acceptance and is no longer allowed by regulators.

A safe, environmentally conscious method to decontaminate energetics residues remaining in washed out chemical weapon burster tubes was developed for the alternative technology assembled chemical weapons sites for the U.S. Army Program Manager for Alternative Chemical Weapons Assessment (PMACWA). The Metal Parts Treater (MPT) was developed to decontaminate projectile and mortar shells contaminated with explosives and/or chemical agent after they are demilitarized. The MPT uses radiative heat, in the presence of superheated steam, followed by catalytic conversion of off gas to reduce organic explosives contaminants. The metals parts are held at greater than 1000 °F for the statutory minimum 15 minutes thereby achieving 5X decontamination level. Superheated steam and electric induction heaters operating in a non-oxidizing atmosphere are used to heat the scrap, thereby eliminating the need for burners or incineration to achieve 5X.

The MPT system is designed to heat contaminated scrap metal in a batch or continuous feed mode depending on feed material configuration. The treatment system uses superheated steam as a heating medium and also as a carrier gas. Nitrogen may also be added in addition to or in place of the superheated steam. The major components of the MPT consist of an alloy steel vessel, external induction heater coils, steam generator, steam superheater, a gas reheater vessel, a quench/condenser, catalytic oxidation (CATOX) unit, lime bed, and an eduction fan.

During the period of December 1998 through May 1999 the Assembled Chemical Weapons Assessment (ACWA)/Water Hydrolysis of Energetics & Agent Technologies (WHEAT) demonstration tests were conducted at the Chemical Agent Munitions Disposal System, Deseret Chemical Depot, Tooele, Utah. Five component technologies including the MPT and CATOX were tested and validated. The MPT demonstration test was intended to validate passive/non-incineration decontamination of munitions and various non-process wastes (dunnage) to a 5X condition with radiant heat and steam as a viable process. The testing was also intended to provide critical data in determining which contaminants are condensed out, and which are destroyed by the CATOX unit. The engineering design scale (EDS) test provided critical information on equipment design parameters and on how conditions change during heat-up. The major components of the near-full scale MPT system built for the EDS testing included the MPT vessel, induction heat generator, electric steam generator, electric superheater, reheater chamber, quench/condenser, catalytic treater, lime bed, and filter unit.

The MPT feasibility test and subsequent EDS tests validated that non-oxidizing, thermal destruction of solid organic wastes with steam is a viable process. The testing provided empirical data for heat and mass balances and DREs. Data was gathered that characterized the chemical nature of the resultant condensate and non-condensable gases before and after processing through the CATOX unit. The tests proved that decontamination with steam not only created an oxygen-free condition but also provides an added advantage of significant (99.99%) steam reformation and vapor phase hyrolysis of

the organic solid waste to less harmful products. The tests have demonstrated that the two key process parameters to achieve 5X conditions are the temperature of 1000°F and an effective carrier medium. The unit is essentially self-contained and transportable, requiring only electrical power and a source of process water for operations to commence.

The MPT test program satisfied all test objectives and demonstrated that the combination MPT unit and CATOX system to achieve 5X condition for scrap metal is a viable, efficient, safe, and environmentally sound way to treat contaminated metal scrap. The MPT is ready for full scale application for 5X treatment of explosives-contaminated range residue and particularly appropriate for locations where incineration-type facilities are not an option. Utilizing an MPT for the decontamination of range residue is a feasible solution that will result in reliable and cost-effective alternative to incineration for achieving 5X level of decontamination for design utilizing validated and approved technology.

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Demilitarization of Aircraft Engine Components Using the Modified Mobile Expended Ordnance Deformer

The combined effort of Naval Aviation Depot Jacksonville (NADEP Jacksonville) and a private company has resulted in the development of an improved aircraft engine component demilitarization and recycling operation with a substantial reduction in process time and an increase in material recycle value.

Used engine components discarded during the rebuilding of jet engines result in more than 600 barrels of used engine components annually. These used components are constructed of valuable metals including titanium, cobalt, nickel alloys, and various other alloys. In the interest of national security and public safety, scrap and surplus military items must be demilitarized before sale to the public. The Defense Demilitarization manual (DoD 4160.21-M-1) specifies those military items that require demilitarization, as well as the extent of demilitarization required. Demilitarization of scrap engine components calls for total destruction of the item and components so as to preclude restoration or repair. Civilian contractors used to perform demilitarization, however cases have occurred where used aircraft engine component have been sold as new engine components. A significant liability is associated with the sale of aircraft engine components for recycling. Also, due to extensive performance requirements, aircraft engine components are constructed of materials chosen for their strength, durability, and other outstanding physical and mechanical properties that create difficulties in the demilitarization of the components. Initially an arc welding process was used to damage the components, however this process has many drawbacks including labor time, contamination of the materials reducing their purity and value, and potential health and safety concerns.

NADEP Jacksonville recognized the need and sought possible solution to improve the demilitarization process. In the search an Expended Ordnance Casing Deformer (EOCD) used by the Army to demilitarize ordnance casings was found. The manufacturer of the deformer was contacted to modify the EOCD to be used for demilitarization of aircraft engine components. Modification to the EOCD design were developed and the Modified Mobile Expended Ordnance Deformer (MMEOD) was constructed.

The MMEOD consists of a hopper, a conveyor that feeds engine components from the hopper into a deformer chamber, and a conveyor to remove engine components from the deformer chamber and deposit them in a collection container. The deformer chamber contains metal blocks attached to a revolving drum, powered by a diesel engine. These metal blocks, constructed of hardened tool steel, strike the engine components as they pass through the deformer chamber, resulting in mechanical deformation of the components. The MMEOD is capable of processing engine components ranging from ½” to 17” in length. The metal composition of the engine components is not changed by the MMEOD.

NADEP Jacksonville partnered with Concurrent Technologies Corporation (CTC) through the Navy Environmental Leadership Program (NELP) to evaluate the performance and efficiency of the MMEOD, and to conduct a cost analysis of the MMEOD process versus the arc welding process. The MMEOD was tested to determine the degree of deformation, to determine if demilitarization requirements as specified in the DoD Demilitarization Manual were met, the efficiency, and

the overall performance including ease of operation, reliability and general design.

The most common engine component sizes and metal types were categorized and used in the testing. Sample lots of 100 pieces from each category were passed though the MMEOD. It was determined that the MMEOD effectively deformed the engine components as specified in the DoD Demilitarization Manual. The efficiency of demilitarization varied due to differences in part size and shape and ranged from 97 to 100 % demilitarization on the first pass and 100% after two passes through the MMEOD. The process time is approximately one minute per pass. This is a significant reduction from the 4-hour process time for one barrel of engine components using the arc welding procedure and results in annual labor savings for the NADEP Jacksonville Recycling Center of approximately 2,400 man-hours.

The MMEOD is very easy to operate and does not require a high level of training. It was found to be well designed and reliable. Some modifications were recommended to reduce the jamming of engine components, lower noise levels, and increase equipment durability. These modifications will be incorporated into the design of future MMEODS.

The estimated annual process cost savings to be realized by implementation of the MMEOD is $59,000 resulting in a payback period on the initial capital investment of slightly less than 2 years.

The MMEOD is applicable but not limited to depot-level facilities and below. Its mobility allows the MMEOD to be shared among facilities that may not have the volume of items necessary to substantiate the purchase of a dedicated MMEOD. When utilized in a facility's recycling and demilitarization program, the MMEOD can be a valuable tool in reducing labor requirements and effectively demilitarizing aircraft engine components.

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Development of Biosorbent Technology for Army Aqueous Waste Streams Containing Heavy Metals

Toxic and heavy metals such as chromium, cadmium, nickel, mercury, and lead contaminated waste streams are generated form the Army's plating, metal finishing, battery, and power generation operations. The Army is looking for better and cost effective technologies for treating the toxic metal waste streams. One possible approach is to use the concept of adsorption technology with a low cost, high efficiency biosorbent material. Using such a cost-effective sorbent material may reduce the overall treatment and compliance costs. Biosorption can be defined as the removal of metal or metalloid species, compounds and particulates from solution by biological materials.

A new composite biosorbent has been prepared by coating chitosan onto ceramic alumina. Chitosan loading on the ceramic support exceeds 20% by weight. The shape of the adsorbent is nearly spherical with an average particle diameter of about 100~150 µm (from Scanning Electron Micrographs). The BET surface area of the biosorbent is about 105 m^2/g, pore volume 0.187 cm^3/g, and the average pore diameter is 71.2 Å. The adsorption capacity of the composite biosorbent was evaluated by measuring the extent of adsorption of metals Cd^{2+}, Cr^{3+}, Cr^{6+}, Ni^{2+}, Pb^{2+} and Hg^{2+} from water under equilibrium conditions at 25º C. The equilibrium data are fitted to Fruendlich and Langmuir isotherm models and the parameters are reported. Using Langmuir isotherm models, the equilibrium data yielded the following ultimate capacity values for the coated biosorbent on a per gram basis of chitosan: 13 mg Cd^{2+}/g, 75 mg Cr^{3+}/g, 79 mg Cr^{6+}/g, 78 mg Ni^{2+}/g, 130 mg Pb^{2+}/g and 370 mg Hg^{2+}/g. In addition, column breakthrough studies were conducted at a pH of 4.0. After the biosorbent column was saturated with the metal, the column was regenerated with 0.1 M sodium hydroxide. Maximum desorption of the metal takes place within 5 bed volumes while complete desorption occurs within 10 bed volumes. The column breakthrough studies show that the coating process has facilitated adsorption of metals process with chitosan. The biosorbent can be improved by properly selecting the support material and by controlling the amount of biosorbent. Additional evaluation of the biosorbent with multi-metal adsorption, column breakthrough, and regeneration studies are recommended. Preliminary evaluation of the biosorbent with chrome plating rinse water chromium from Rock Island Army Ammunition Plant, Rock Island, IL, was conducted. Results of these studies have not yet been reported. Continuous flow adsorption and regeneration studies and studies with wastewater samples from contaminated sites are in progress to obtain the overall process economics.

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Cost Savings Through Reutilization of Used Hydraulic Oil

The U.S. Army, in cooperation with industry, recently developed and demonstrated a methodology for returning used hydraulic fluid to vehicle service. The effort was conducted in three phases: First, a laboratory investigation to determine the viability of restoring used fluid to military specification performance. Second, a field investigation designed to identify commercially available equipment that could successfully process the used fluid and also demonstrate the performance of the restored fluid in military vehicles. Third, the Army entered into Cooperative Research & Development Agreements (CRADA's) with commercial companies that manufacture the certified hydraulic oil recyclers to test on-line diagnostics aimed at automating and optimizing the process.

The approved methodology of returning used hydraulic fluids to Mil-spec performance, developed jointly by the U.S. Army and industry, involves removal of contaminants from the fluids and revitalizing fluid additives. By removing the contaminants, laboratory studies have shown that the fluid properties can be restored to as good or better than MIL-specification requirements, except for in some cases, the foaming characteristic. It is essential that particulate and water contamination be removed from used fluid, because contamination can lead to premature wear as well as possible malfunction of hydraulic components. The concern of foaming due to the depletion of anti-foaming additives over long-term use prevents the simple removal of contaminants as the only treatment required. The Fuels and Lubricants Technology Team determined that the addition of new hydraulic fluid in the appropriate amount (25%) was sufficient to restore decontaminated, used fluid to specification performance.

To date, one company, Pall Aeropower Corporation has successfully developed affordable technology. Pall Automated Hydraulic fluid Recycling Unit removes particulate contamination and incorporates a water sensor as a means of detecting water content of the fluid. Typically the particulate contaminants are removed long before all of the water is removed. After a time delay, set to ensure particulate clean-up, the automation package interrogates the water sensor to determine when the relative humidity level of the fluid being reconditioned drops to a level corresponding to 500 PPM water (or the limit set for the specific MIL-spec). Once all of the criteria are met, the recycler shuts off automatically.

The U.S. Army Environmental Center is supporting technology transfer by collecting important cost and performance information and hosting field demonstrations. They have estimated that the cost to recycle FRH using the Pall recycler is less than $3.00 per gallon depending on site conditions, fluid contamination, and available workforce. The typical procurement cost of new FRH is over $10.00 per gallon. Disposal costs vary greatly from near $0.00 to over $3.00 per gallon. The Pall unit is now certified by the U.S. Army, Navy, and Air Force to restore hydraulic oil to Mil-spec performance without degrading the properties of the fluid. Several commercial purifiers /recyclers are certified by the Army, however, the Pall unit is the only one now certified by the Army that has the automated water sensor and is commercially available.

The on-site reutilization of used hydraulic fluid with a certified hydraulic oil recycler can have a significant impact on meeting pollution prevention goals. The benefits include reduced fluid disposal costs, reduced procurement costs for new fluid, and an uncomplicated avenue for conservation of natural resources. Procedures and certifications for this program are now in place. The implementation of a hydraulic oil-recycling program will save millions of dollars per year for each of the U.S. military services, as well as contribute to readiness. For more information contact: Ralph B. Mowery (MoweryR@tacom.army.mil; Dennis A. Teefy (Dennis.Teefy@aec.apgea.army.mil); or Neal C. Werner (neal_werner@pall.com).

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DENIX: Technology for a New Era

With the onset of the technological age, the Internet has, for many, become a primary and essential tool for accessing information. DENIX, the Defense Environmental Network and Information eXchange is the Department of Defense (DoD) Website for Environmental Security Professionals. Information related to current events, news, and environmental, safety and occupational health (ESOH) are available at the website for users worldwide.

Environmental policy at DoD is developed from the Office of the Deputy Under Secretary of Defense for Environmental Security (DUSDES). For DoD, the DENIX website is used as a vehicle to disseminate policy and guidance information. Located at http://www.denix.osd.mil, DENIX facilitates the exchange of information and ideas between DoD Environ-

mental Security professionals, representatives from other Federal, State and International government organizations and the general public. Users can access ESOH information in the areas presented in Figure 15.

To date, there are close to 10,000 active account users involved with ESOH programs. These users range from the installation level to individuals involved at the policy-making level of the DUSDES Office.

DENIX provides access to four different types/levels of information. This information is of interest to DoD personnel, State staff, the general public, and individuals with an interest in the international arena. Specifically, DENIX houses information on: 1) bilateral and trilateral agreements, 2) DoD-State pollution prevention (P2) partnerships, DSMOA program and ECOS, 3) public access to DoD's environmental stewardship activities, and 4) DoD publications, legislative and regulatory data, and draft documents. In addition, information on upcoming conferences, workshops, conference proceedings, policy documents and reports are available. DENIX offers access to proprietary information sources such as the *Daily Environmental Reporter*, *Inside EPA Weekly Report*, *Inside OSHA*, IHS/ENFLEX (datasets for federal and state laws and regulations), and the *Daily Regulatory Reporter*. Links to other environmental, safety, health, fire and international links are also accessible. In addition, DENIX provides access to information for the Army, Navy, Air Force, and DLA and is used as a vehicle to disseminate information for various organizations. DENIX users also have access to list serves and discussion forums. The ultimate goal is for DENIX to become a one-stop knowledge station for all DoD environmental security professionals.

- Air
- Alternative Fuel Vehicles
- Cleanup/Restoration
- Climate Change/ODS
- Compliance
- Conservation and Natural/Cultural Resources
- Ergonomics
- Environmental Planning
- Explosives and UXO
- Hazardous Substances
- International Activities
- ISO 14000
- Land
- Material Safety Data Sheets (MSDS)
- Munitions
- Noise
- PCBs
- Pest Management
- Pollution Prevention
- Recycling
- Safety/Occupational Health/Fire
- Toxic Substances
- Waste
- Water

Figure 15. ESOH Information at DENIX

For additional information, please contact Jackie Hux, Technology Team, Inc., DENIX Data Managers at (703) 256-6661.

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